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ABSTRACT

A series of educational experiments are being conducted in Canada on the Communications Technology Satellite. The description of these experiments reveals a diversity not previously encountered in educational applications of satellite systems. In evaluating these experiments, the authors adopted Stufflebeam's Context-Input-Process-Product model in order to include in their investigation the wider problem of institutional assimilation of new communications technology, as well as issues of instructional effectiveness. To date the project has shown that organizational constraints were more severe than experimenters had expected and that multipoint conferencing is very sensitive to technical quality. Although some of the experiments were very short, the project has demonstrated that satellite communications have applications in education which go beyond the classical telelecture. (Author/JEG)

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# THE EDUCATIONAL EXPERIMENTS WITH A COMMUNICATIONS TECHNOLOGY SATELLITE: A MEMO FROM EVALUATORS TO PLANNERS

by

J.S. Daniel
M.L.Cote
M. Richmond

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# EDUCATIONAL EXPERIMENTS WITH THE COMMUNICATIONS TECHNOLOGY SATELLITE: A MEMO FROM EVALUATORS TO PLANNERS

J.S. DANIEL, M. L. Côté, M. Richmond

Télé-université

3108, Chemin Ste-Foy, Québec, Canada G1X 1P8

ABSTRACT

A series of educational experiments are being conducted in Canada on the Communications Technology Satellite. The description of these experiments reveals a diversity not previously encountered in educational applications of satellite systems. In evaluating these experiments, the authors adopted Stufflebeam's Context-Input-Process-Product model in order to include in their investigation, as well as issues of instructional effectiveness, the wider problem of institutional assimilation of new communications technology. To date the project has shown that organizational constraints were more severe than experimenters had expected and that multipoint conferencing is very sensitive to technical quality. Although some of the experiments were very short the project has demonstrated that satellite communications have applications in education which go beyond the classical telelecture.

## 1. INTRODUCTION: THE CONTEXT

### 1.1 An experimental satellite programme

Made in Canada and launched by the U.S. on January 17th 1976, the Communications Technology Satellite is a joint venture between the two countries. Intended as an experimental rather than an operational satellite its novel features are firstly high power (200W) and secondly the frequency at which it receives and emits (12-14 GHz). High power in the satellite means that smaller and cheaper ground terminals can be used, whereas communicating at a high frequency part of the radio spectrum means less congestion and

less interference with terrestrial facilities. In concrete terms this means that terminals can be placed in cities (e.g. on the roofs of buildings).

The objectives of the Canadian Department of Communications in the CTS project were stated as:

1) To enhance in Canada a capability in the design and manufacture of spacecraft subsystems for domestic use and export.
2) To maintain a Canadian capability to specify, assess and construct space application systems for domestic use.
3) To develop and flight test spacecraft subsystems and components for use in future communications satellites.
4) To conduct communications experiments to explore the use of future high-power communications satellites in Canada to low cost ground stations in the 12 and 14 GHz bands.
5) To explore by means of communications experiments the social, cultural and economic impact of the eventual introduction of services that might be provided.

Clearly the CTS project was justified to the Canadian Government principally on the basis of the technical developments and experiments which it would permit. Important components of the experiments were the study of the attenuation of 12-14 GHz signals under different weather conditions and of the use of wave polarization to increase channel capacity. However, these and other technical experiments required relatively little satellite time so because of a growing realization that communications satellites were not an end in themselves, the government invited institutions and organizations across the country to propose experiments in social communications to be carried out on CTS. About forty proposals were studied in the areas of education, telemedecine and social interaction. The present article is limited to the educational experiments which have been carried out in Canada since the satellite was launched.

### 1.2 The institutionalization of new educational technology

From his experience with educational innovations in the US and the UK Hooper 1) has listed factors which facilitate the assimilation of new technology in educational institutions. Some of these factors are:

1) The technology answers real needs linked to the primary objectives of the institution.
2) The technology blends in with technology already being used.
3) The team responsible for implementing the technology is integrated into the institution and not a peripheral tack-on.
4) Serious attention is given to training personnel to use the technology.
5) The institution puts up some of its own resources in order to

use the technology.

6) The technology has high visibility both within and without the institution.
7) The use of the technology is evaluated.
8) Different departments and institutions collaborate on the project.
9) The technology favours reforms and developments already under way in the institution.
10) The technology has high transferability.
11) Existing equipment and courseware can be used with the technology.

Many of these conditions were fully or partially met by the institutions participating in the CTS project. Carleton University, the first experimenter, had already acquired, in its Wired City Laboratory, experience of the use of telecommunications in education whereas the second experimenter, the University of Quebec, uses teleconferencing on a routine basis and had already taken part in satellite exchanges.

However, despite these apparently favourable circumstances the highly important first condition in Hooper's list could only be partially met because of the experimental nature of the CTS project. The length of the periods allotted to experimenters (a few months) and the timetabling of satellite time within these periods (afternoon and evening slots on alternate days) were not designed to fit university sessions and course schedules. Furthermore the uncertainty which properly surrounds an experimental project meant that any institution using the satellite for a vital function had to have a back up system ready.

For these reasons the CTS educational experiments were viewed within participating institutions as an opportunity to acquire familiarity with the technical and organizational constraints of satellite communications and to explore various applications. Before contemplating any permanent operational satellite system all experimenters would wish to run pilot projects for longer periods than was possible with CTS.

## 2. THE EDUCATIONAL EXPERIMENTS

Before discussing the evaluation of the experiments and their implications for planners we shall describe the aims and configurations of the experiments which will have been completed by the time this symposium is held. Four types of terminal were involved:

| Diameter | Location/mobility | Function |
|---|---|---|
| 1m | Portable | Emit and receive audio |
| 2m | Transportable | Receive video; emit and receive audio |
| 3m | Mobile (truck mounted) | Emit and receive video and audio |
| 9m | Fixed (Ottawa) | All of above plus control and telemetry |

In the text these terminals will be designated by their diameters (e.g. 3m).

Two institutions, Carleton University (Ottawa) and The University of Quebec, carried out experiments between the summer of 1976 and the spring of 1977. Two other projects, those of Memorial University (Newfoundland) and the Federal Public Service Commission, began in spring 1977.

### 2.1 The Carleton-Stanford curriculum exchange

This project combined both technical and educational objectives. The basis aim was to use the satellite to allow students at Stanford University in California to take courses originating in Ottawa and vice versa. In one mode one class was simultaneously originated at each end and communications to the remote students were provided by means of one way video and two way audio. In the other mode two way video was used to enable a fuller interaction between the ends of the link. In addition to satellite technology the exchange used experimental methods of television signal processing. These digital processing methods, which permitted transmission of video signals from 2m. terminals, were developed by the NASA Ames Research Centre, a partner in the project. In simple terms they doubled the capacity of the video channel.

The first course exchanges by satellite began on October 19th 1976 and for the rest of the term five courses were available at both universities. These were.

| Originating University | Course Title | Hours per week | Number of students | |
|---|---|---|---|---|
| | | | Carleton | Stanford |
| Carleton | Digital Systems Architecture | 3 | 25 | 5 |
| Carleton | Computer Communications Systems | 3 | 30 | 15 |
| Stanford | Management of Research Institutions | 2 | 20 | 30 |
| Stanford | Statistical Methods in Signal Analysis | 3 | 6 | 20 |
| Stanford | Seminar course | 1 | Variable | |

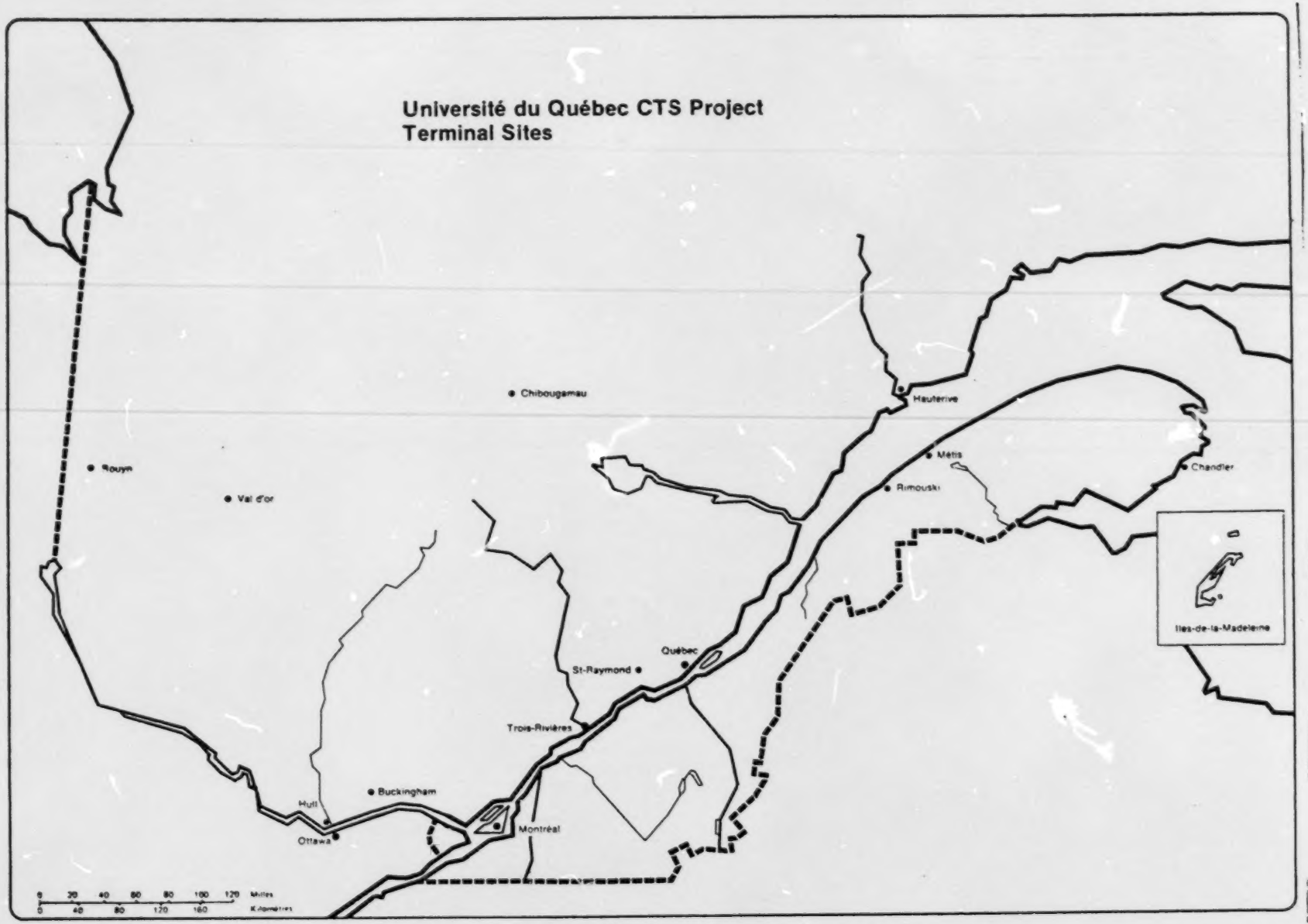
In the winter term, only one course was offered in each direction.

## 2.2 The University of Quebec Omnibus Network

The only multi-campus university in Canada, the University of Quebec already had experience of satellites through its involvement in France/Quebec exchanges in the Comminsat Frabec and Symphonie programmes. The University's CTS proposal differed from those submitted by other institutions in that the content of the experiment was purposely left undefined. The satellite would be used to create a communications network between the campuses and local centres of the university and the whole university community would be invited to submit projects. Of the thirty experiments submitted fifteen were carried into the planning stage and the nine experiments of which descriptions follow have been conducted.

Another of the original features of this project was the requirement to move terminals to set up different networks. Thus the 3m terminal was located successively at Montreal, Trois-Rivières, Quebec and Rouyn and the smaller terminals were moved correspondingly.

2.2.1 Electron Microscopy (3m: Montreal; 2m: Trois-Rivières, Quebec, Rimouski) The satellite allowed interactive research discussions between bacteriologists in Montreal, Quebec and Trois-Rivières. The other sites received live images from an electron microscope in Montreal and discussion centred on identifying viruses and bacteria. Videotapes, reprints etc. could be called up at will and the electron microscope adjusted in real time to provide the field and magnification requested by the distant participants.


Université du Québec CTS Project
Terminal Sites
Chibougamau
Rouyn
Val d'or
Hauterive
Métis
Chandler
Rimouski
Iles-de-la-Madeleine
Québec
St-Raymond
Trois-Rivières
Buckingham
Hull
Ottawa
Montréal
0 20 40 60 80 100 120 Miles
0 40 80 120 160 Kilometres

2.2.2 Teledocumentation (2m: Rimouski; 1m: Chandler; telephone: Hauterive) Since library services pose a problem for off campus courses the satellite was combined with rapid facsimile transmission equipment to make documents available for students in a Business Management course organised by the Rimouski campus in the towns of Hauterive and Chandler. Students used the audio link to discuss their needs with the Rimouski librarian who sent out the appropriate texts by rapid facsimile transmitter through the satellite.

2.2.3 Telereference (3m: Trois-Rivières; 2m: Rimouski) Although somewhat similar to 'Teledocumentation' this project, which involved the University's libraries in Rimouski and Trois-Rivières, included a one way video link. Students in Rimouski could see the reference librarian in Trois-Rivières to whom they explained their needs. The video link was also used to show tables of contents, abstracts etc. to help the student zero in on the most appropriate reference text. The chosen text was then transmitted by satellite using the rapid facsimile equipment.

2.2.4 Centre for the Development of Learning Environments (CDES) (3m: Trois-Rivières; 2m: Quebec) At any given time the CDES is involved in innovative projects with teachers in a number of schools around the province. The satellite was used (one way video - two way audio) for consultation between CDES staff and teachers in the Quebec City area. The objective was to study the effect of a consultation where each participant is in his everyday milieu. The traditional form of consultation implies that each participant is either visited or a visitor and it was hypothesized that this influences the consultative interaction.

2.2.5 Graduate course in public administration (3m: Quebec; 2m: Hull) One of the only classical teleteaching projects carried out in Quebec, this experiment brought three sessions of a masters course from the University's Graduate School of Public Administration in Quebec City to students in Hull. The one way video link from Quebec to Hull was used to transmit images of the instructor and his transparencies etc. and discussion took place over the two way audio link. The objective was to study the changes in behaviour which such an arrangement both requires and provokes on the part of both the instructor and the students.

2.2.6 Radio Orbital (2m: Montreal; 1m: Iles-de-la-Madeleine) An ambitious project to link the Iles-de-la-Madeleine with emigré islander communities in Montreal and Chicoutimi for a Christmas communications jamboree, this experiment unfortunately fell foul of numerous technical problems. One multipoint radio session took place over landlines but the more intimate telephone sessions had to be abandoned.

2.2.7 Oceanology (2m: Rimouski; 1m: Métis) This was a technical experiment to use the satellite for transmitting oceanographic data on wave heights, conductivity, salinity, temperature (and gradients), depth and turbidity from the probes to the computer.

2.2.8 Western Quebec (3m: Rouyn; 2m: Hull (link with Ottawa 9m); Val d'Or, Chibougamau) The University's centre in Western Quebec, CEUOQ, serves a sparsely populated area of 200,000 square miles. Already involved in various teleteaching and telemanagement projects, the CEUOQ used some 50 hours of satellite time for telework sessions, teleconferences, and a telelecture course. Some seven sites were involved.

2.2.9 Intercom (3m: St-Raymond, 2m: Buckingham (link with Ottawa 9m) Scheduled for the end of the University's experimental period, this project linked community TV stations in two widely separated small towns. Some 500 citizens took part in exchanges on a variety of topics and the stations' ratings hit an all time high.

### 2.3 Memorial University
(3m: St. Johns; 2m: Stephenville, St. Anthony, Labrador City, Goose Bay-Happy Vally)

Starting in March 1977, this project linked St. John's with Stephenville, St. Anthony, Goose Bay-Happy Valley and Labrador City. The satellite was used for four types of activity.
- Continuing medical education for physicians.
- Continuing nursing education.
- Community health education.
- Consultation services and transmission of medical data.

### 2.4 The Public Service Commission
(3m: St. Johns; 9m: Ottawa)

This experiment has both technical and educational objectives. Four groups in St. John's were linked with Ottawa for a course in long range planning. Using a multiplexing technique developed by Miller Communications Systems Ltd., the TV images from the four rooms in St. John's were sent to Ottawa over a single video channel. From the educational point of view interest centred on the non-directive mediated learning model which was used in the course. This experiment ran from April through June 1977.

## 3. EVALUATION OF THE EXPERIMENTS

Each experimenter is responsible for evaluating his own project and the present authors have been charged with conducting an overall assessment of the CTS educational experiments with a view to developing models for the future use of satellites in Canadian education. In the University of Quebec experiment, for example, this meant that three groups of people took part in the evaluation, the individual experimenters, a University of Quebec team reviewing the project overall, and the CTS educational evaluation group. Although such a structure obviously works against the rapid publication of results since each group interprets the raw data before passing it on to the next, it has the advantage of involving many people in an evaluative appraisal of the project.

The present authors proposed to the experimenters an evaluation procedure 2) based on Stufflebeam's Context-Input-Process-Product model 3) and drew up a series of instruments covering the following aspects of the experiments:

- Technical and interactive aspects (questionnaires for participants and site coordinators)
- Participant satisfaction (questionnaire)
- Project staff data (questionnaire)
- Checklists for interviews with experimenters, instructors, facilitators and participants)

Experimenters could either use some or all of these standard questionnaires as provided or modify them to increase their relevance to a particular experiment. Naturally institituions also had their own special evaluative interests. Thus Carleton University used a questionnaire on attitudes to educational technology developed over the years in its Wired City Laboratory and the University of Quebec placed strong emphasis on interviews and observation with the aim of analyzing the type and quality of the interactions taking place.

Although the present authors had proposed a standard data processing format this has not been used by experimenters to date. Each experimenter is the first to compile and interpret his evaluation data and this process is under way at the time of writing. Since little of this data has yet been plassed to our team the comments and conclusions which follow are based largely on interviews and observations which we have made ourselves over the preparatory period and during the first six months of experiments.

### 3.1 Context evaluation

We began this article by adumbrating the context of the CTS

project. Having described the experiments themselves some further comments are in order.

3.1.1 Experiments or demonstrations? If an experiment necessarily implies an experimental or quasi-experimental research design then the CTS project is better described as a series of demonstration applications of satellite technology. There were no control groups and the experimenters themselves seemed rather uninterested in the issue of educational effectiveness although this question seemed to loom large in the government planners' minds at the start of the project. In this respect the experimenters were probably right since the results of the now famous Dubin and Tavaggia 4) survey on comparative studies of instructional media revealed 'no significant difference' with great regularity. Furthermore a recent conference devoted exclusively to the evaluation of educational TV and radio 5) came to the conclusion that ten years activity in this area had produced little of lasting value. In this context the experimenters were sensible to concentrate on 'having a go' with satellite communications in order to test their acceptability to both users and the institution and determine whether this technology was worth exploring further.

3.1.2 Objectives or placebos? Since objectives became an obsession in the world of education there has grown a tendency for the writing of them to become an art form divorced from real life. The CTS project did not always escape this tendency and some of the objectives identified by the experimenters beforehand now have a faint air of pomposity. The University of Quebec was lucid enough to realize that the objectives it stated for the overall Omnibus Network experiment were not necessarily shared by individual sub-experimenters. In general, the somewhat rarified metalanguage employed by experimenters and sponsoring agencies at the beginning of this type of project creates confusion and misunderstandings once the project gets under way.

3.1.3 Evaluators or participants? Evaluators usually complain that they were involved in the project too late. We are glad to say that our team began work in plenty of time - long before the experimenters had even begun to think about evaluation. No attempt was made to maintain the stance of detached observers for one of our roles was to help experimenters design their project and its evaluation and to advise on instructional issues at the planning stage. However, we do not believe that this strategy significantly contaminated any of the experiments!

### 3.2 Input evaluation

3.2.1 Dollars or dimes? The educational component of the CTS programme was not generously funded. This was not necessarily a bad thing although it would have been better had the experimenters been able to employ elsewhere the considerable energies they had to devote to raising the meagre (by US standards) funds they got. Hooper 1) has noted that educational projects which depend on generous outside funding do not have a high survival rate once the external source of money dries up. It already seems clear that the necessity of blending the CTS experiments into normal institutional activities and structures so as to affect resources to them will ensure that CTS leaves a more permanent trace than a more lavishly conceived programme might have done.

3.2.2 Organization or improvisation? We are grateful to the experimenter who explained patiently to us that universities always did things at the eleventh hour and made a success of them all the same. It is easy to say that the experiments could have been better planned but more difficult to prove that this would have made a difference. Some indication will be obtained by comparing the first two experiments with the later and better prepared projects of Memorial University and the Public Service Commission.

As with objectives, organizational charts can become an independent art form. In one experiment in particular the impressive organization of the project on paper bore no relation to the way the operation was really run. A possibly laudable attempt to both respect the hierarchy and encourage widespread participation in planning and execution actually caused considerable confusion as people tried to discover where the real lines of communication and authority were.

3.2.3 Men or supermen? It was impossible to follow this project without gaining considerable admiration for the people who made it work. From the instructor who spent twenty hours a week preparing his satellite courses to the site coordinator who could get up the three flights of stairs from his control booth to the terminal on the roof in a matter of seconds, CTS involved a large number of people working long hours on an overload basis. Whether the effort involved in educational satellite exchanges could be reduced to workaday proportions in an operational educational system is a major question.

### 3.3 Process evaluation

3.3.1 On or off? Problems with the power supply of the satellite itself caused uncertainty just before the experiments began and again in the winter of 1977 when the decision to continue experiments during the eclipse was taken at the last minute. Both events increased experimenters' difficulties.

3.3.2 Mobile or transportable? The ground terminals used in the project were not sufficiently rugged and reliable. This particularly affected the University of Quebec experiment which involved moving terminals several times and into some pretty remote places. An operational system would require better equipment.

3.3.3 Analog or digital? The technology of digital TV being in its infancy some problems were expected with the Carleton Stanford link. Although there were momentary image break-ups with increasing frequency as time went on the overall success of this spectrum saving system is a tribute to the engineers at the Nasa Ames Research Centre.

3.3.4 Business or housekeeping? During the Carleton-Stanford course exchanges administrative details (e.g. set books, exams) took more time to organize than had been expected and during the University of Quebec project sub-experimenters often complained they didn't know what was going on. The experimenters advise those involved in similar enterprises to set aside at least 10% of satellite time for housekeeping purposes. Similarly in the University of Quebec experiment telephone contact by landline was often maintained throughout sessions to ensure efficient and unobtrusive communication between site coordinators.

3.3.5 Two or more? The University of Quebec project provided a sharp reminder of the difference between multipoint interactive conferencing and the more traditional one to many (broadcast) and one to one (telephone) communication modes. In multipoint conferences technical problems, nearly always associated with the sound and frequently with echos, were often obtrusive. It seems that neither the experimenters nor the CTS programme control foresaw these problems sufficiently to install the efficient audio teleconferencing equipment that already exists 6). However, the existence of even a one-way video channel makes poor sound more tolerable (by reducing uncertainty) than in a solely audio system.

### 3.4 Product evaluation

Although it is too early to make any conclusive statements about the value of the projects of the CTS experiments a few comments can be made.

3.4.1 Telelectures and tele-education. Although the telelecture courses conducted over the CTS have been successful the project has shown that the possibilities of tele-education by satellite do not end there. The electron microscopists' research seminars, the telereference library consultation experiment and

and several of the teleconferences generated considerable enthusiasm amongst participants.

3.4.2 Audio vs video. Since nearly all the Canadian educational CTS experiments involve asymmetrical communication links the data which has been gathered should permit comparison of participant attitudes to different communication environments carrying a common content. For the moment, we hypothesize that for telelectures the one way video/multipoint audio mode produces less interaction than the multipoint audio mode, simply because with video instructors make less effort to implement the interactive telecommunications teaching techniques described by Parker 7). The addition of one way video to a multipoint audio system does prove useful for research seminars, teleconferences and telework sessions.

3.4.3 Classical vs romantic. Wedemeyer 8) has suggested that satellites should not and will not provide a 'highway in the sky for conventional teaching and learning". In the CTS project although the institutions given time on the satellite were all part of the conventional educational establishment the activities conducted were not all classical in nature. It is unfortunate that the most unconventional (romantic) educational experiment, the University of Quebec's Radio Orbital, fell foul of technical problems. However the Intercom project provided a foretaste of a new type of educational communication.

3.4.4 Satellites in education: the cost. We have mentioned (para 3.2.1) that the CTS experiments were largely absorbed into the financial bloodstream of participating institutions. This makes exact costing of the experiments impossible, a situation they share, incidentally, with most educational activities. A separate cost study is being conducted 9) on the space, ground, infrastructural and instructional costs of two hypothetical educational satellite networks.

## 4. CONCLUSIONS: A MEMO TO PLANNERS OF FUTURE SATELLITE PROJECTS

Our experience with the CTS educational experiments in Canada indicates that the Hooper checklist given in para 1.2 provides useful guidelines for planning an experimental or operational satellite system for educational purposes. Particular attention should be given to the following items.

### 4.1 Go for real needs and primary objectives

Ensure that the pompous metalanguage of experimental objectives does not detract attention from using the satellite for useful

purposes. Do not mix technical and educational experiments unless you are sure that the technical innovation will work.

4.2 Involve your own resources and organize them for the job in hand

A few people full time on the project will give better results than a larger number of part timers. When planning satellite classrooms or studios consider air-conditioning an essential, not a luxury.

4.3 Train your personnel

Technical staff, instructors and evaluators all need training before the project starts. This was a weak aspect of the CTS project which probably explains why participants in the experiments (e.g. students, researchers) appear to have been more satisfied with the project and interested in continuing it than were the staff running the experiments.

4.4 Work at circulating information

Somewhat ironically for a communications experiments, a common complaint within participating institutions was that nobody seemed to know what was going on. Organize bulletins and information sessions so that the project has high visibility and participants can see the whole picture.

4.5 Involve experimenters in evaluation

Make sure that roles and duties within the overall evaluation plan are clear. Be prepared for the tendency of experimenters to hoard their data.

## 5. ACKNOWLEDGEMENTS

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